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## Abstract

- Voluntary disclosure of information can improve cooperative behavior in *resource provision* game.
- Our paper makes two contributions: (i) *Common Pool Resource (CPR) extraction* instead of public good provision & (ii) Analysis of different types of information sharing.
- The main objective is to investigate whether information sharing and which kind of disclosure can help reduce resource extraction.
- Findings:**
  - Mandatory Disclosure (MD) leads to highest extraction level, supporting previous findings (negative role of full information in CPR).
  - Voluntary Binary Disclosure (VBD, i.e. people choose whether to display their decision and the information revealed is the effective extraction level) gives the lowest levels of extraction (as in the case of resource provision).
  - Voluntary Free Disclosure (VFD, i.e. people choose whether to display their decisions, but they can lie about the effective extraction level) increases resource extraction towards the MD level.
- Implication: MD and VBD are costly while VFD can reveal free-riders.

## Introduction

- Having information on resource appropriation becomes essential in order to sustainably manage natural resources.
- Examples: smart grids in electricity provision, remote metering in domestic water use, carbon disclosure program, etc.
- Regulation of groundwater is growing because of rapid depletion of the aquifers (due to overexploitation, drought, etc.).
- Sustainable Groundwater Management Act in California adopted in 2014:
  - Groundwater Sustainability Agencies must adopt plans by 2020 for groundwater basins.
  - Users located in unmanaged area must report their extraction information to the State Water Resources Control Board.
  - Collecting self-reporting extraction information (by the GSAs & the State Water Board) is highly important to build sustainable plans.
- Two important issues:
  - Collecting extraction information is *costly*.
  - Double dilemmas: *CPR dilemma* (due to extraction decision) & *Social dilemma* (due to information sharing).
- Research questions:** In a CPR game, does information sharing reduce resource extraction? What type of information disclosure is the most efficient?

## Literature

- Coordination failure in common goods (Olson 1965, Hardin 1968).
- Information sharing*, communication, trust can boost cooperation in groups and communities (Ostrom 2010, Poteete et al. 2010).
- Voluntary disclosure of information can improve cooperative behavior: in *resource provision* (Kreitmair, 2015), illegal behaviors (Cialdini et al. 2006), forest degradation (Lim et al., 2017), social dilemmas (Dawes, 1980).
- A *boomerang effect* (reduced cooperation) may exist (Ostrom & Walker, 2003).
- Full disclosure leads to high extraction in CPR (Villena & Zecchetto, 2011).

## Methods and Materials

- Framed experiment (Cox et al., 2013).
- Player *i*'s payoff ( $i = 1, \dots, N$ ):  $\pi_i = 3y_i - 0.01875Y^2$ 
  - $y_i$ : individual extracted amount,  $0 \leq y_i \leq E$ ;  $Y = \sum_i y_i$
  - Total available resource:  $N \times E$
- 104 players randomly assigned into groups of 4 players ( $N = 4$ );  $E = 10$ .

Table 1. Summary of treatments

Treatment	#Periods	#Groups	Voluntary sharing	Choice of declaration
Mandatory Disclosure (MD)	20	8	No	No
Voluntary Binary Disclosure (VBD)	20	9	Yes	No
Voluntary Free Disclosure (VFD)	20	9	Yes	Yes

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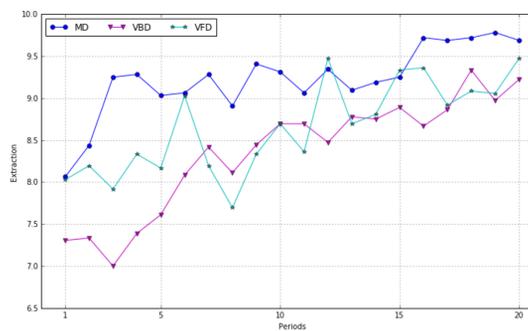
## Conjectures

- Conjecture 1:** Voluntary disclosure of information will be chosen by agents, consistently with Kreitmair (2015).
- Conjecture 2:** Voluntary disclosure increases cooperation (i.e. VBD and VFD extractions are lower than MD extractions).
- Conjecture 3:** In VBD and VFD, free-riders will not share their extraction levels.
- Conjecture 4:** The more freedom is given to agents in information sharing, the more cooperative they behave.

## Results

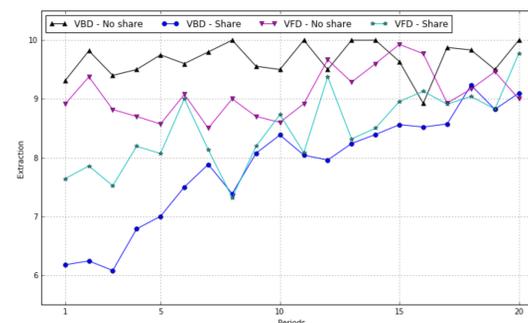
Table 2. Estimation results from a dynamic Tobit model with correlated random effects. Dependent variable is individual extraction.

Variable	Coefficient	Standard errors
Initial individual decision	0.178*	0.095
Individual decision in previous period	0.006	0.061
Group decision in previous period	0.133**	0.030
Decision-making time	-0.049**	0.010
Treatment VBD	-1.830**	0.563
Treatment VFD	-2.171**	1.040
Time trend	0.163**	0.019
Intercept	-8.229	5.148



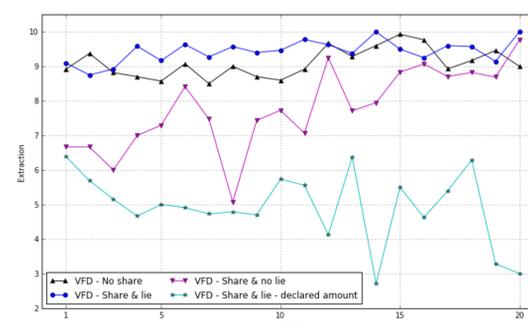
- People choose to voluntarily disclose their information.
- VBD and VFD extraction levels are lower than those in MD.
- VBD and VFD are not significantly different.

Fig 1. Average extractions



- Players sharing information extract a high (and stable) amount, while other players increase their extraction (as conditional cooperators).
- Free-riders seem not to share information.

Fig 2. Extractions & sharing



- Liars extract more than honest players and are closed to those who don't share.
- Players who declare and do not lie increase their extraction as conditional cooperators.

Fig 3. Extractions & sharing and lying

## Discussion

- Conjectures 1-3 are verified.
- Conjecture 4 is partly verified.
- Taking information cost into account (MD cost > VBD cost > VFD cost), the result does not support the MD which is currently implemented in some programs.
- The possibility to declare the extraction level is less costly than other treatments but leads to lower cooperation (those who extract more are also those who lie).

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